Mission in Vietnam
February, 15th to 24th, 2009

ADAM project

Research and Development Program proposal 2009 – 2012

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Sommaire

1- Terms of References

Short-term mission: support to planning of DMC experiments adapted to perennial crops based cropping systems in the mountainous areas of Vietnam

1. Context

1.1. ADAM Project with NOMAFSI and CIRAD

Funded by AFD, ADAM project (support to agro-ecological approach in mountainous tea-production area of Vietnam), is implemented by NOMAFSI with technical assistance from CIRAD. It aims to significantly contribute at setup and develop durable and productive farming systems in the North-West of Vietnam, especially through 3 components:

-Development of DMC farming systems integrating agriculture, livestock and plantation at farm level (Component 1)

-Reinforcement of national teams' capacities through professional training on DMC (Component 2)

-Valorisation and communication (Component 3)

Tea is selected as a model plant, from which technical results will be extent to other perennial crops (coffee, rubber, fruit trees plantations, etc). This project is implemented in synergy with a global development project of tea sector also funded by AFD (end 2005; 8.5 million Euros).

1.2. Vietnamese tea sector

Vietnamese tea sector is essentially export-oriented (84% of the production equivalent to 75.000 tons of tea were exported in 2002, for an 82 million US$ estimated value). Although Vietnam remains a small-scale actor on worldwide market (roughly 3% of the worldwide tea production and 5% of exports carried out), its presence increases quickly (Export volume was multiplied by 6 during the past 10 years). From a social point of view, more than 250 000 agricultural households (more than 1 million people) live thanks to tea related activity which induces both direct and indirect employments. Sector's mutations accelerate under the combined effect of various factors: increased pressure on natural resources, emergence of demands for more ecological productions, etc.

1.3. Importance of tea sector in Phu Tho Province

Tea is the major industrial crop of Phu Tho Province (more than 10% of the cultivated area). Total tea planted area exceeded 10,000 ha in 2003, while annual production of green leafs reached approximately 45.000 tons. Areas under contract with industrial companies (beneficiating from a private credit system based on output furniture to be reimbursed on leaf payments by factory) exceed 25% of the total planted area with an average yield of 9 t/ha of green leafs (almost 2.5 t/ha of dry tea). Balance of tea planted area (75%), is cultivated on small-scale plantations (0.1 ha) by independent peasants, with an average yield ranging from 3.5 to 4 tons of green leafs per hectare (0.8 to 0.9 ton of dry tea). This level of yield is weak by comparison, on one hand, with average yields in other countries (India), and on the other hand with experimental yields obtained in NOMAFSI plots.

1.4. Other perennial crops

Besides tea, other perennial crop as rubber, coffee or fruit tree are grown in the project's area. Their potentialities remain to be assessed.

2. Main goals targeted by the mission

This mission aims to:

-analyze key factors and needs of production means regarding farming system diversification based on perennial crop's investment;

-define and validate a proposal of demonstration-training experiments targeting the development and application of DMC principles to the major perennial/annual crops on the basis of tea model.

3. Specific objectives

Specific goals of this mission are listed as following:
- review of key factors determining the farmer's capacity to invest in perennial crops;
- definition and validation of experimental research-development-training device;
- valorization.

4. Tasks to be achieved

From the date funds will be available, following tasks should be achieved:

4.1. Short review of conditions, determining factors and constraints to the investment in and development of perennial crop based cropping systems by farmers

On the basis of i/ bibliography, ii/ basic agro-economic data relative to the major perennial crops based cropping system and iii/ a few interviews with key actors and small-scale farmers located in project's area, tasks to be achieved are:
-description of key factors (investments required, production means, markets, constraints) determining the farmer's capacity to develop perennial crops based cropping systems;
-analysis of the hierarchical structure of key factors determining the capacity a farmer has to mobilize investment in plantations (tea, coffee, rubber, fruit trees) in the farms located in project's area (preceding organization of farming / cropping system, conditions of soil fertility and field location (altitude); market's opportunities; time of return on investment; local agricultural planning, inciting policies, etc);
-analysis of the variability of agricultural strategies aiming to minimize the duration of return on investment when a farmer invests on a plantation.

4.2. Support to the definition of research-development-training experimental device.

In coherence with objectives targeted by the project, tasks to be achieved are:
-support to the definition of experiments to be carried out by the project;
-validation by project's team of the suggested technical schemes and experimental device.

4.3. Mission capitalization

Tasks to be achieved are:
-organization of a joint restitution involving AFD Vietnam, MARD, NOMAFSI and CIRAD;
-redaction of memorandum draft and its transmission to the Project;
-integration of possible remarks in a final memorandum.

5. Mission preparation

With the goal to insure a strong efficiency, a preparatory work to be led by the project is recommended. It includes:
- logistics and administrative preparation (appointment, field round trip, etc.) allowing discuss with actors and farmers;
- collect of basic agro-economic indicators and helpful data which will contribute understanding farmers' strategies and constraints when they invest in perennial crop based cropping system (work requirements for agricultural activities, labor and land productivities costs of opportunity, constraints a farmer has to deal with);
- consideration on experimental device (goals, location, relationship between owners of land, possibility to build pre-extension network), etc.

6. Mission schedule

The duration of the mission is limited to seven days, including one day for sub-regional travelling, five days of field work and one day for drafting.
This mission will be led from February 10, 2009 to February 17, 2009. It is scheduled as following:

2/15/2009	Travel Phnom Penh – Hanoi
2/16/2009	Meeting with AFD, NOMAFSI, CIRAD and MARD Travel from Hanoi to Phu Tho Meeting with NOMAFSI / ADAM project staff
2/17-19/2009	Field trip (agronomic experiments of NOMAFSI and interviews / meetings with farmers located in project's

	area (Son La, Yen Bai, Phu Tho) - Return to NOMAFSI
2/20-21/2009	Definition of experimental device Validation by NOMAFSI Travel from Phu Tho to Hanoi
2/22/2009	Redaction of memorandum - restitution to AFD, CIRAD, NOMAFSI and MARD
2/23/2009	Travel Hanoi - Phnom Penh

7. Budget estimates

The maximum budget allocated to the mission is 5 000 Euros. It was built taking into account the following expenditures:
-administrative and travelling costs (visa, plane ticket);
-housing and accommodation;
-consultation fees;
-expenses of edition / transmission of memorandum.

Budget estimates was established on the basis of 7 day including 1 day for travelling, 1 day for drafting and 5 days of field work. The expenditures related to the mission will be charged on component 6 of the project's financial plan under the heading "mission, trip study, follow-up, evaluation" - counterpart CIRAD.

From a logistic point of view:
- A provision of 500 Euros is budgeted to cover travelling expenses of expert (visa, international transport, housing and accommodation) ;
- A provision of 4200 Euros is budgeted to cover fees of expertise and redaction ;
- A vehicle with a driver and an interpreter will be placed at the expert's disposal for the whole mission. Expenses of fuel and lubricant, maintenance and reparation of the vehicle will be charged to the project ;
- A provision of 300 Euros is budgeted for data acquisition, edition and memorandum transmission ;

Activities	**PU**	**Number**	**Total (Euros)**
Human Resources expenses (1)			
Driver put at expert's disposal	-	-	Pm
Interpret put at expert's disposal	-	-	Pm
Fees of expertise (mission, redaction)	600	7	4200
TOTAL (1)			**4 200**
Functiuning expenses (2)			
Plane ticket Phnom-Penh / Hanoi / Phnomh-Penh, visa	150	1	150
Housing and accommodation	50	7	350
Vehicle put at expert's disposal	-	-	Pm
Fuel/lubricant/reparation	-	-	Pm
TOTAL (2)			**500**
Investment expenses (3)			
Data acquisition (maps and report duplication)	150	1	150
Memorandum redaction, edition and transmission	150	1	150
TOTAL (3)			**300**
TOTAL (1) + (2) + (3)			**5 000**

2- Mission sequence

- Sunday 15th
  - pm : Flight Phnom Penh – Vientiane – Hanoi
    Meeting with Damien Hauswirth (CIRAD UPR 1)
- Monday 16th
  - am : Meeting with AFD staff – rural development sector
  - pm : Transfer to NOMASFI research station (Phu Hô Commune – Phu Tho Province) (ex. Tea Research Institute - TRI)
    Visit of Tea experiments on Station (25 ha) and potential experimental plots on the NOMAFSI - Tea company (# 200 ha)
- Tuesday 17th
  - am : Meeting with ADAM's direction and research team - presentation of the Tea sector
  - pm : Interviews of Tea farmers around Phu Hô – Visits of tea plantation
- Wednesday 18th
  - am : Transfer to Yên Bai Province
    Visit of Suôi Giang area – medium elevation: Shan Tea and annual crops (Maize, Cassava) on steep slopes (Karst)
    Rice Plain of Nghia Lô – Irrigated Rice based tests and trials with farmers (hybrid var., transplanting density …)
  - pm: Meeting at the "Joint stock Van Chân Tea company" – Nam Bung Commune
    Visit of a recent Shan Tea plantation; prospective development work implemented by the Company with farmers (# 500 ha) with support from NOMASFI (initiated by Ex-TRI in 2002)
    Transfer to Than Uyên (Lai Châu province) via Tu Lê commune, Mu Cang Chai district
- Thursday 19th
  - am : Transfer to Lai Châu province
  - pm : Visit of small scale clonal trials (planting 2008) in Co Muông village (Phong Thô district, Không Lao commune) clones behaviour test (GT1 and RRIV 4, also planting 2008) in Binh Lu' commune (Tam Du'o'ng district) both implemented by RRIV with NOMASFI support for monitoring
    Way back to Tu Lê
- Friday 20th
  - am : Way back to Phu Thô province
    Meeting with HaDevA local NGO : Cooperative for Support and Consultancy on Agricultural development in Ha Hoa district
  - pm : Way back to NOMASFI centre at Phu Hô
- Saturday 21st
  - am : Mission debriefing and first proposal on program design with ADAM team
  - pm : Return to Hanoi
    Dinner with CIRAD's colleagues D. Hauswirth, P. Grard and families
- Sunday 22nd
  - am : Drafting
  - pm : Meeting with P. Lamballe
- Monday 23rd
  - am : Debriefing at AFD
    Meeting at CIRAD DRASEC office with D. Jourdain (CIRAD – UMR G Eau)
    Short discuss in NOMAFSI representative office in Hanoi with Ms. Thuy, deputy director of NOMAFSI's international cooperation department and head of training component for ADAM's project
  - pm : Drafting

- Tuesday 24th
    - am : Flight Hanoi – Vientiane – Phnom Penh[1]

3- Met persons

NOMASFI

- Dr Lê Quôc Doanh – Director
- Mr Hà Dinh Tuân – Deputy director of NOMAFSI and coordinator of ADAM project
- Mr Lê Dinh Giang – Manager of the CIDTAF company
- Mr Dang Van Thu' – Researcher, Tea specialist (ADAM)
- Mr Nguyen Quang Tin – Researcher, Annual crops specialist (ADAM)
- Mr Lê Huy Hoàng – Researcher, Agroforestry (ADAM)
- Mr Dang Trân Viêt – Researcher, Tea specialist (ADAM)
- Mrs Hà Thi Thanh Doàn – Researcher (ADAM)
- Mr Phung Quôc Tuân Anh – Researcher, Rubber trial monitoring
- Mrs Dinh Thi Nguyet Nga – Translater and Accountant (ADAM)
- Mrs Nguyên Thi Thanh Thuy –Deputy director of international cooperation Department of NOMAFSI, Training component (ADAM)
- Mr Dang Dinh Quang, head of agrarian system department (unfortunately not met)

AFD

- Mrs Nguyên Thuy Anh – Responsible of the Rural development branch
- Mr Pham Trung Kiên – Projects supervisor

Peoples Committee of Yên Bai Province

- Mrs Trân Thi Kim Hông – Responsible of the International Cooperation p.m. collaboration with "Conseil Général du Val de Marne"

Tea Sector

- Mr Pham Ngoc Chien – Farmer at Phu Hô
- Mr Hà Thai Hoc – Farmer at Phu Hô (IPM approach)
- Mr …. – Technical director of the Tea Van Chân company
- HaDevA (hadeva.hahoa@gmail.com)
    * Mr Nguyên Kim Trong – Director (ph. 098 62 88 386)
    * Mrs Nguyên Thi Thuyêt – Deputy Dir. in charge of Tea operation (not met)

GRET

- Mr Patrice Lamballe, Country representative and responsible of the Luong bamboo Development Project

CIRAD

- Damien Hauswirth
- Damien Jourdain
- Pierre Grard
- Paule Moustier

Thanks to all encountered persons for having shared their time and to NOMAFSI for the mission organization.

[1] It has not been possible in such a short time mission to organize visit in Son La Province. No specific demand related to this area (especially on Môc Châu district, important tea production area with apparently better technical and economic results than in Phu Tho and Yên Bai province) arose during discussion with ADAM teams

Abbreviations

AFD – Agence Française de Développement

CIRAD – Centre de Coopération Internationale en Recherche Agronomique pour le Développement

NOMASFI – Northern Mountainous Agriculture and Forestry Science Institute

RRIV – Rubber Research Institute of Vietnam

TRI – ex Tea Research Institute (now part of the NOMASFI)

TSP – Tea Sector Project (2005-2010), funded by AFD on Phu Tho province

Introduction.

ADAM project marks the "rebirth" of Research and Development actions on Agro-ecology and DMC technologies in Vietnam after the end of the SAM project (Systèmes Agraires de Montagne, 1998 - 2005).

Due to important rearrangements among research institutes in charge of upland agriculture in North Vietnam with the creation in 2005 of the NOMASFI by the gathering of:

- the Northern Mountainous Agricultural Research Center (NOMARC),
- the Tea Research Institute;
- the Fruit Research Centre of Phu Ho;
- the Coffee Research Centre of Ba Vi.

… and the suspension of large projects funding on Agro-ecology, DMC based R & D actions have been limited on the Northern mountainous areas[2] in the recent years.

But the creation of NOMASFI should allow, in the future, securing agro-ecology and DMC development on long term tracks; ADAM project offers the opportunity to set research basis addressing some of the key challenges faced by agricultural activities on the sloping areas of the 15 Northern provinces.

After Le Quôc Doanh and Ha Dinh Tuân (2008), it is reminded that this region represents:

- around one third of the national territory (11 millions ha),
- 13 millions inhabitants "split" in 36 ethnic minorities, with poverty rate significantly above national mean,
- only 1,5 million ha covered by agricultural activities, including 0,5 million ha on sloping fields (more than 60% of the surface present slopes steeper than 25°).

But most of the upland annual crops systems -with apparently important extension for corn and cassava in the recent years- practiced in these regions include a fallow period when land productivity fall ; so, the total area allocated to agriculture by farmers' communities -but not permanently cropped- should be much higher than the surface indicates in the above statistics.

Increasing demographic and economic pressures -with the rapid shift from extensive staple food to annual cash crops productions (notably with the high demand and prices' attractiveness of corn and cassava sector since 2006/07 cropping seasons – increasing incentive from "new" private stakeholders)- contribute to speed up degradation of the natural resources (soil, water, biodiversity) in these fragile environments (see photos n°).

Any R & D program for agriculture in these regions must be driven by two general objectives:

- sustainable management of the mobilized natural resources, including efficient proposals for the short-term rehabilitation of degraded areas,
- poverty reduction which implies to take into account, all along the technologies' design process, how poor farmers will access to the requested productions factors.

In these prospective, it must lead to a double output:

- technologies design, conditioned by physical parameters, market opportunities (or any other goals for production);
- prospective orientations on extension methodologies, progressively taking into account the various types of farms (goals x productions factors availability and access which can be modified here by specific social organizations of Ethnic minorities).

Up to now, sustainable management of uplands was mainly planned and attempted through the development of perennial crops based sector, including the large public programs of "bare hills and

[2] Contact should be taken with RRIV team involved on DMC R&D within Agricultural Diversification Project in Central regions (1998-2005); see Mr. Le Gia Trung Phuc (legiatrungphuc@yahoo.com), now director of the RRIV centre for Rubber Smallholders in An Loc, first to complete food, fodder and cover crops germplasm.

slopes rehabilitations" by fast growing trees mono-cropping (Eucalyptus sp., Acacia mangium, etc). If these approaches present the clear advantage to introduce and develop economic sectors in poor regions, it is now admitted that perennial crops do not necessary mean sustainability of the production systems.

From an agronomical point of view, it is, for instance, largely proven that some problems of replanting occur after hardy pulp trees species cycles like Styrax sp., Eucalyptus sp., Acacia sp. … largely promoted in the past decades. See also, below, comments on tea plantations' management.

From an economic point of view, these development orientations have been carried out through the close integration of small-scale family agriculture with downstream agro-industrial sectors, with an important leading role, in the past, of the State Owned Enterprise, e.g. GERUCO - VRG for Rubber, VINATEA, VINACAFE …). If these development schemes have shown obvious efficiency for the technologies transfer, credit and land access in the implementation phase, they may progressively lead to "unbalanced" relationships between smallholders and companies; these relations, where farmers have little possibilities to add value to their gross product -combined with a lack of information on big, fast and "mysterious" market price's variations-, may be more and more felt as "unfair" by farmers. These "feelings" could become a constraint for processing agro-industries which need to improve the quality of their products to address evolutions of markets' demands.

Apparently, similar approaches are "mobilized" for the first developments of Rubber plantations in Lai Châu province with a close monitoring of new farmers' plantations (no precise information was available on the kind of contractual relationships between farmers and companies) and VRG's companies (Vietnam Rubber Group, ex GERUCO).

Tea sector provides an example of this "mistrust" between stakeholders which slow down a requested shift toward higher quality:

- farmers' point of view could be summarized (and simplified) as follow: why to improve quality by better but more intense plucking practices and "softer" pests control methods if higher quality is not sufficiently paid by companies; especially when, in the mean time, trends to "*extensification*" on tea management are strengthened by increasing labor price and off-farm labor opportunities
- companies point of view: why to pay for quality when there is little warranty that the requested standards will be matched (especially for pesticides residues).

Evolution on the Bamboo project (Luong bamboo Development Project, LDP) carried out by GRET in Thanh Hoa Province could be also considered as an illustration. After an initial phase focusing on cultivation promotion (access to planting material, design of cropping systems, training …), the LDP more and more focuses on increasing added value for farmers organizations. Its main assumption is that it is a way to stabilize the sector within farmers communities who are highly reactive to prices' variations and opportunities offered by new attractive market; e.g. young bamboo plantations threaten by Cassava prices' raise in 2007/08 in a context of increasing competition between sectors on a scarce land resources …

Following proposed orientations and protocols for the ADAM's R & D component are principally built around:

- systemic and thematic experimentations on Tea, addressing some key agronomical, technical and economic problems faced by the tea sector

  * systemic[3]: (1) agro-ecological approaches for new plantation implementation, (2) immature period management (including implementation of cover crops one year prior tea planting), (3) rehabilitation of plantations on degraded land

  *thematic: fertilizer dose x variety type, plucking systems comparisons (impact on quality + assessment of return on "investment" in labor force), effect of soil's smouldering ("Ecobuage") at planting, of "strong roots effect cover crops combined with lower soil's disturbance planting, runoff control under tea plantation …

[3] Possibility to adapt and "prolong" results to other perennial crops

- experimentation systems "*on farms, with and for farmers*" on DMC based management of annual crops for sloping upland (+ possibility to extend and adapt results to "dry terraces", according to their importance in farming systems)

Geographical localization of this program, for both topics' types, should be specified through a compromise between:

- the "theoretical" necessity to re-cross main "regions" -defined by a combination of agro-ecological zones combined with socio-economic trends-…which is quite difficult to assess regarding high variability of specific local contexts in Northwestern area of Vietnam … too huge number of "types": high multi-scale ("*fractal*") physical variability in mountainous areas, high social differences -more than 30 ethnic minorities-, complex and moving economic trends under various "pressures" gradient (migrations, competition between economic sectors … ? … all dynamics to be understood through an agrarian and tea management practices diagnosis -collaborations with Mr Dang Dinh Quang and NGO's tea farms network- and integrated in the agro-technical proposals design),
- logistic, human resources and costs constrains !

In first approach, it is proposed to implement:

- Tea experimentation systems[4] between:
  - Phu Tho province (control area in NOMASFI station + CIDTAF company, farmers networks possibly in connection with both Tea sector project and HaDevA's supports)
  - Yên Bai province, Van Chân district … continuation of the pilot work on Shan Tea new plantations development initiated in 2002 through a collaboration between TRI and the "Van Chân tea company" (VCTC – see photos n°); experimentation could be structured by a work on quality improvement -mainly based on on-farm trials- and completed by a prospective study on a "Shan tea" geographical appellation development (take benefits of the "neighboring" experience on geographical appellation development for the "Tu Lê sticky Rice").
- Annual crops based experimentation between:
  - Phu Tho province (mainly, implementation of "perennial" collection for both food crops and fodder-cover crops species and varieties)
  - Yên Bai province, Van Chân district, Nam Bung commune (choose on the transect between VCTC and Tu Lê – see photos n°), for the annual crops systems development; the main experimental systems (mixing control experimentation in the village and progressive development of an on-farm pilot extension network) should be based in Nam Bung commune and connected to the work implemented by IRRI and CPWF project cf. Ha Dinh Tuan, Damien Jourdain, Pham Van Cuong, Do Anh Tai, Dang Dinh Quang, October 2007
  - on the bottom of the slopes (valley and terraces); benefits of the socio-economic characterization studies already done and provide complementary works on upper sloping lands ; the cropping systems design will be, here, carried out on soils developed on acidic rocks substratum (dominant area and larger "land reserve", higher agro-technical constrains) and complete the works already implemented by NOMASFI on the Karst regions of Suôi Giang commune -important market based Corn and Cassava dynamics- (Ha Dinh Tuân and Nguyên Quang Tin).

[4] The proposed locations for Tea experimentation could be completed by works in Son La Province (not visited during the mission) -especially Môc Châu area-, if any specific topics of interest in this region (apparently with better technical and economic performances for Tea production than Phu Tho and Yên Bai)

1. Tea based experimentations

From an agronomical point of view, the Vietnamese tea sector is facing 2 main challenges:

1/ development of really sustainable cropping systems; the rapid transect across Phu Tho and Yên Bai provinces done during the mission (from red river delta to mountainous areas) have clearly allow to see obvious and widespread proofs of heavy soils degradation under tea plantations (heavy erosion, low organic matter return, insufficient fertilizers applications …); it seems that soil's evolution -probably due to Tea plant hardiness- has been neglected by farmers and only recently perceived and taken into account by research, with contradictory results (see Minh V. Dang, 2004; Pomel 2007,)

2/ tea quality improvement with a shift to high quality variety, quality plucking improvement and pesticides residues reductions (mainly insecticides with an apparently widespread use of broad spectrum active ingredients: various pyrethrinoïds and imidacloprid); today Vietnamese tea still suffer of a 20 to 30% under-valorization on international market.

… and those evolutions have to be implemented under the double pressure of high competition for land access between agricultural sectors (land productivity improvement) and fast labor cost increase in the recent years (labor productivity); today, farmers seems to favor high yielding varieties (e.g. LDP1 and LDP2) and more extensive plucking practices with notably progressive mechanization development for the most integrated farms leading to medium-low quality products (CTC-black tea quality –relation between quality type and mechanization development should be précised through the initial practices diagnosis).

DMC based agro-ecological approaches in tea plantation could be part of the answer to these challenges by:

(1) allowing sustainable management of the soil resources and tea production;

(2) favoring biological control of the main insects pests (increasing efficiency of already promoted IPM -Integrated Pests Management- approaches);

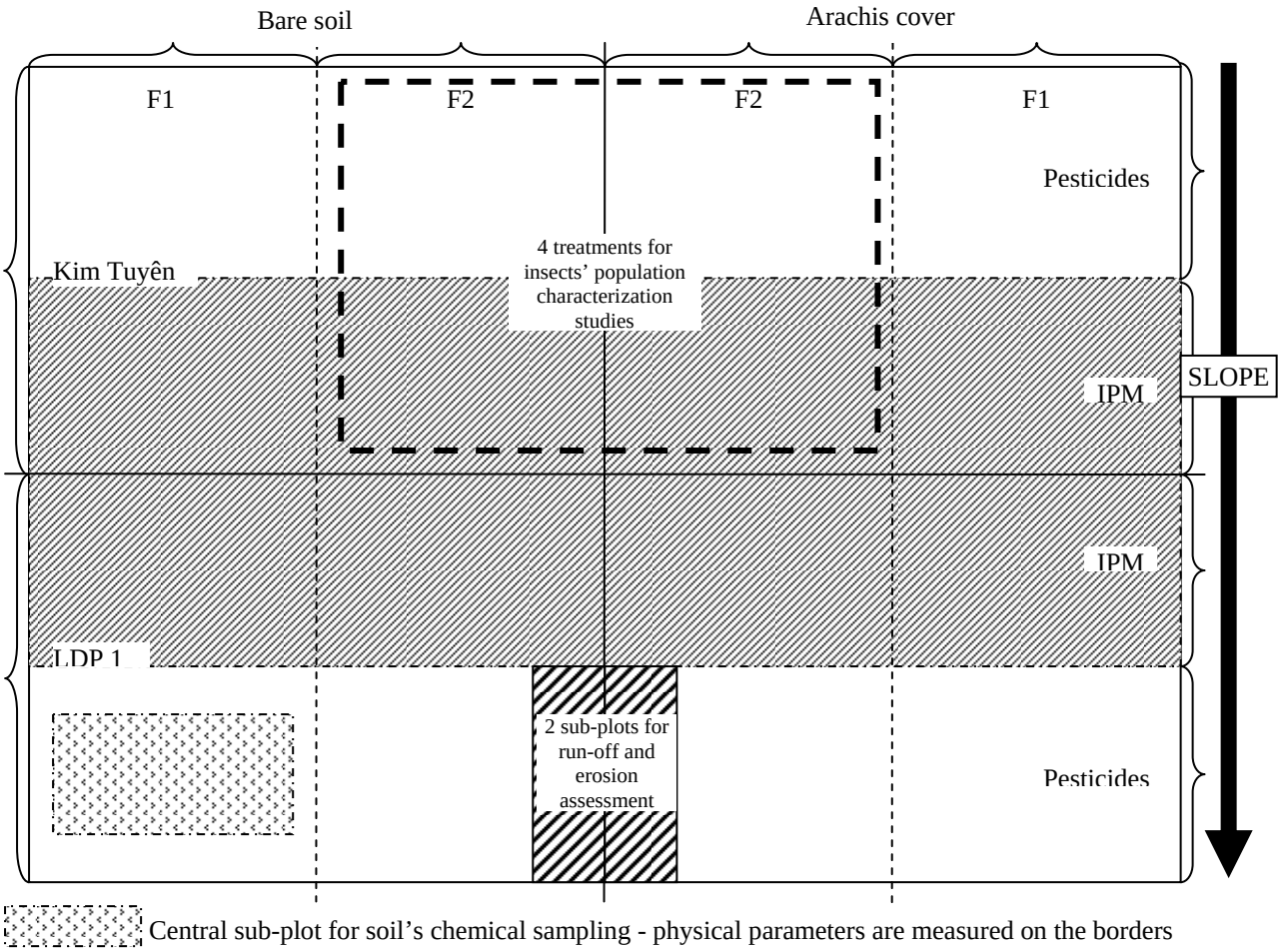
(3) Possible improvement of gustatory quality (interactions between soil improvement and taste of tea).

1.1 DMC based systemic approaches – Controlled area experimentations

1.1.1 Tea "Matrix "

Proposal for a Tea long-term "matrix" experimental design combining 4 factors (2 levels/ factors),

- Soil type management: bare (reference) *vs.* Arachis pintoi cover
- Variety type: high yielding (LDP type) *vs.* top quality (Kim Tuyên)
- Fertilizers level: low-F1 (representing around 50% of the recommendations … still higher than most of the farmers practices) *vs.* high-F2 (recommended dose)
- Pest control method: pesticide based *vs.* IPM approach



16 elementary plots of about 600 m² [5] (e.g. 20 m large x 30 m long)
Total area: around 1 ha
Implementation 2009
Location: Phu Hô station (or CIDTAF plantation)

Precisions on factor's levels (proposal to be also discussed with Mr Dang Vang Thu', Tea specialist)

- Soil cover management
  - Bare soil
  - Arachis pintoï cover

[5] to be validated preliminary discussions with entomologist for the minimum size of the elementary plot allowing assessment of treatments' impact on the entomofauna; 600 m² represents also a reasonable size for labour time measurements

N.B. - Arachis pintoï is already introduced at a large scale on the NOMASFI tea station; recommended species for soil cover may evolve with the screening cover crops species experimentation – see below
- In Y.0., prior to tea planting: Tea planting is preceded by a corn crop (on ploughed soil or light hoe tillage according to the slopes); for the cover crop treatment, Arachis cuttings are implemented in the corn's interrows (possible use of 3 000 g/ha of alachlore as Pre-emergent herbicide application for weeds control) ; same fertilizers applications on Maize for all treatments
- IMPORTANT: in order to minimize Arachis pintoï disturbance at Tea planting, the tea lines will be implemented on the corn line (1 line/2); for tea planting (discuss recommendation with Mr Dang Van Tu'), target a density around 18-20 000 plants/ha, with lines every 1,40 m (Maize sowing every 70 cm) in bare soil treatment and 1,60 m (Maize interrow = 0,8 m) in cover crop based one (increase light on cover).

- Variety
  - high yielding: LDP1,
  - top quality for Trung Du area (low midlands): Kim Tuyên
- Fertilizer level - see table below

	Y.0.	Y.1.	Y.2.	Y.3.	Y.4. and Y.i.
F1	Regular practice at planting	20-15-15 in 2 applications	30-60-20 in 2 applications	40-20-30 in 2 applications	30-15-23 / 2 t of harvested fresh tea leaves in 3 applications
F2		40-30-30 in 2 applications	60-120-40 in 3 applications	80-40-60 in 3 applications	60-30-46 / 2 t of harvested fresh tea leaves in 6 applications
		40 kg/ha ZnSO4 10 kg/ha B 10 kg/ha MnSO4 5 kg/ha CuSO4	Applied for the 3 "immature years" Y.1. – Y.3., at the 2nd fertilizers applications of the Y.1.		2 kg/ha ZnSO4 / 2 t … 0,5 kg/ha B/ 2 t … 0,5 kg/ha MnSO4/ 2 t … 0,25 kg/ha CuSO4/ 2 t …

All "N P K" applications are done with simple fertilizers:
- Urea for N, along line in Y.1 and Y.2; on all soil's surface from Y.3
- Thermo Phosphate for P (+ Ca, Mg, SiO2) applied on all soil's surface
- K2SO4 for K (if not possible, replace by KCl and 50% of the N applications are done with $(NH4)_2SO4$ … for S supply); application idem Urea

N.B. - No Organic matter (manure, compost …) applications (except at planting if recommended); if they are part of the theoretical recommendations, they are likely extremely limited in the farmers practices (little availability, transportation …); permanent plant cover is likely the best way to maintain and improve soil's organic matter status
- From the Y.4. , the total NPK applications are much higher on the high yielding variety than on the top quality one, less productive.
- Check availability among the numerous cement plants of the regions the availability of Filler (residue of electro-filter, which could be use as a very cheap and efficient –thin powder- source of Ca ; take several samples and analyzed contains Ca, Mg, K and S) ;

- Pest management
  - Pesticides based : based on survey data on most common farmers practices
  - IPM based : see IPM recommendations from Y.2 (introduce use of Beauveria sp., Trichogramma sp. …)

N.B. - cover crop based management may strongly enhance efficiency of IPM approaches by favoring ecosystem diversity and dynamic stability i.e. favoring survival of introduced auxiliary organisms

Measurements

- Cost and Labor time assessment for all operation – special care on plucking labor time
- Tea monitoring

- During immature period, growth is assessed by diameter measure at 5 cm high (caliper) – 4 times a year on the 2 or 3 middle rows of the e.p.
- Biomass (assessment of carbon inputs' linked to OM return with tea annual pruning) (e.g. 6 samples of 5 m long on border rows) – all cut biomass are kept in the interrow
- Production of fresh tea leaves on the 2 or 3 middle rows of the e.p. ; Tea harvest based on "best quality" plucking practices on all treatments
- See possibility for Tea quality assessments (taste -?-, pesticides residues)

- <u>Soil's parameters evolution</u>
  - Chemical parameters : sampling in Year 0, prior to tea trenches digging, on the middle of the future tea interrow ; 3 bulk samples made of 10 elementary samples taken on the on the "central sub plot" ; sample at 0-5, 5-10, 10-20, 20-30 cm depth, re-sampling every 3 years
    - pH water, pH KCl (or CaCl2)
    - SOM, Total N
    - Total ECC (at pH 7), exchangeable bases, H^+, Al^{3+}
    - Exchangeable phosphorus (resin or Melhich)
  - Physical parameters
    - Texture, particles density with first soil's samples
    - Bulk density (same depth)
    - Water speed infiltration (double ring methodology)
    - Erosion, from the end of the Y.1. (once cover crops fully settled), 2 subplots for erosion measurement are settled on neighboring treatments (bare soil and Arachis cover - see indicative plan and photos n° …); all eroded soil is collected from the 2 downward ditches, dried and weighed every month (rain are measured by a rain-gauge set up close to the experimentation) ; possibility to occasionally measure the run-off water, e.g. right after a big rainfalls by collecting water from the ditch)

- <u>Insects populations</u>
  - Proposal to be discussed with NOMASFI entomologists
    - From Y.3., once cover crops and tea almost fully "set up", practices yearly sampling campaign for qualitative characterization of the associated entomofauna (combined various sampling method: "butterfly net" for aerial large insect, yellow basins with water at the tea "table" level, sticky yellow paper for small aerial sp. e.g. Jassids, buried "cups" for ground insects …) – characterization of interrelations between species
    - See possibility of quantitative assessment for both pests and predators

1.1.2 Cover crops and shading species “screening” experimentations

Two approaches could be combined to implement a soil cover in order to “fully” control erosion and increase C inputs in/on soils:

- implementation of a permanent cover, i.e. screen for shade tolerant species and/or possibility to maintain by seeds (Take benefits of the first years Y.0 – Y.2 to create a large seeds stock in the interrows - possibility to regrow, after the yearly winter pruning -which allow light to reach soil before full re-shading by tea- with first “spring” rains)
- sowing of fast growing species in the middle of the tea interrows in early March.

Arachis pintoï control			
Chamaecrista rotundifolia	Lotus uloginosus	Desmodium intortum	Trifolium semipilosum
complementary sp.	complementary sp.	complementary sp.	complementary sp.
Arachis pintoï control			
C. rotundifolia + Paspalum notatum	C. rotundifolia + P. conjugatum	C. rotundifolia + Axonopus compressus	C. rotundifolia + Pennisetum clandestinum
A. pintoï + Paspalum notatum	A. pintoï + P. conjugatum	A. pintoï + Axonopus compressus	A. pintoï + P. Clandestinum*
Arachis pintoï control			

* Pennisetum clandestinum var. Kikuyu — · — · — · — : useful row for tea measurement

Permanent cover crops tested collection; design to assess 16 species or associations (see Mr. Ha Dinh Tuân for complementary species proposals)
Elementary plots: 2 interrows - 1 “useful” tea line for growth and production assessment on 10 m long (minimum) ; if possible Tea interrow of 1,60 m
Tea variety: if possible, top quality (and slower growth speed), Kim Tuyên
Implementation: 2009 for the Tea planting, 2010 for the cover crops
Total area: around 0,1 ha
Location: Phu Hô station (or CIDTAF plantation); see possibility to replicate the collection in Van Chân district

Cover crops are implemented at the beginning of the rainy season in the young tea plantation (Y.1.). Fertilizers level “F1”

Observation of the C.C. species behaviour in association with tea (capacity to maintain a cover along the year with the progressive shade "intensification", biomass production …)

Bulked Soil sample can be taken at CC implementation on each elementary plots and store; re-sampling, 3 years later, is carried out only on the cover crops presenting potentialities for association with tea ; practice analyses on the Y.1 and Y.3 samples for the selected species (+ all A. pintoï control)

This experimentation will allow a pre screening of "practicable" plant cover species; once several species identified (and management), statistical experimentation would be implemented in order to have a more precise assessment of the impact of the various plant cover on Tea productivity, Soil's parameters evolution (C, N …, water …).

Similar experimental design to assess fast growing species (implemented every year, at the beginning of the rainy season – mid March)

Permanent cover crops tested collection; design to assess 16 species or associations (see Mr. Ha Dinh Tuân for complementary species proposals)
Elementary plots: 2 interrows - 1 "useful" tea line for growth and production assessment on 10 m long (minimum); if possible Tea interrow of 1,60 m
Tea variety: if possible, top quality (and slower growth speed), Kim Tuyên
Implementation: 2009 for the Tea planting, 2010 for the cover crops
Total area: around 0,1 ha
Location: Phu Hô station (or CIDTAF plantation) and Van Chân (with Shan tea planting)

Control with bare soil
Tested species, sown on 1 or 2 coupled lines (at 20 cm distance), in the middle of the Tea interrow:

- Legumes sp. and other dicot.
  - Crotalaria retusa
  - Crotalaria spectabilis
  - Crotalaria juncea
  - Aeshynomene histrix
  - Aeschynomene Americana
  - Vigna unguiculata (possibility of harvest with short cycle var.)
  - …
  - Buckwheat (Fagopyrum esculentum – likely possibility to harvest)
  - Radish (Raphanus sp. – not harvested !)
  - …
- Grass species
  - Eleusine coracana
  - Millet (Pennisetum typoïdes "var." "pool preto")
  - Pennisetum purpureum
  - Sorghum (e.g. var. Irat 203, 377 …)
  - Panicum maximum
  - Corn (short cycle and/or harvested for fresh cobs consumption)
  - …

N.B. - Once several species identified, possibility to work with species associations in combination with permanent soil's cover crop species (paraquat spraying with mask, prior to species sowing in the middle of the interrow)

Similar experimental design to assess high value timber species as shading trees (long term capitalization within Tea plantation – some species have value higher than 2 500 USD/m^3)

Design to assess 8 species (see Mr. Ha Dinh Tuân for complementary species proposals)
Elementary plots: 7 rows - 50 m long (e.p. 500 m²) - 5 associated trees per e.p. (i.e. # 100 trees / ha) planted on the middle tea line (no tea plant on 0,75 m on each side on the tree) every 10 m (first tree at 5 m from the plot's border) – Planting by large polybag from 1 year nursery

Implementation: 2010 for the Tea and associated tree planting
Total area: around 0,8 ha
Location: Phu Hô station (or CIDTAF plantation) and Van Chân (with Shan tea planting)

Control with traditional shading species (Indigofera sp.)

Proposal for species assessment (see forestry specialist for possible complementary proposal):

- Albizia lebbeck (already known as possible shading sp.)
- Dalbergia cochinensis ("Rosewood")
- Dalbergia sossoo
- Grevillea robusta (Proteatcea fam.; Australian Silver Oak – proposal of Pierre Grard)
- See possibility to add some association with fruit trees sp. (see collection and fruit trees specialist of Nomasfi – several references in literature –mainly from China- with e.g. Kaki, Citrus sp., Prunus sp. …

1.2 DMC based systemic approaches – Farmers' plots networks

1.2.1 Rehabilitation of degraded tea plantations

From the second project years (2010), according to:

- 1st results and observation in collections of cover crops and associated trees species
- surveys and data collections[6] on farmers' tea plantations (structured in simple typology based crossing "physical parameters" - *e.g.* age, variety, diseases, "shape", …-, "current technical-economic performances" -yield, quality, income, type of market connection …-, and place of the tea plantation in the farms' production system…),

… ADAM will implement a farms' tea plantations experimental network on rehabilitation proceeds (principally on Phu Tho province + prospective interest on Son La main Tea areas) in order to:

- assess performance (effect on production quality and quantity x cost) of "rehabilitation" packages: pruning, pulling out old bushes, complement replanting (in case of low density), shading and soil protection measures according to typology of initial "degradation states"
- and then help <u>to define a "grid" of decisions and technical proposals for rehabilitation proceeds or orientation on replanting</u>

1.2.2 New plantations network

Also from 2010, ADAM progressively implements a network of farmers' new plantations integrating "best" designed recommendations, based on a combination of:

- a "tea package" focused on quality (variety, shading, fertilizers and pest management)
- soil protection measures before tea plantation (improved fallow and DMC based cropping system prior to transplant tea cuttings)
- soil protection measures, especially during the immature period; several proposals could be built and proposed to farmers according to their objectives (surveys and TSP data will precise the existing practices):
    - "intensification" with intercropping during 2-3 years; progressively built proposals with DMC based systems -see below "Matrix"- starting with a cover crops implementation (*e.g.* in association with a Maize cycle) prior to

[6] Surveys will have to integrate results and data collected across farms involved in the "Rehabilitation component" of the "Tea Sector Project" in Phu Tho province ; on farm experimentations should be developed in connection with both TSP's farmers and NGO supported farms networks (see HaDevA and others members of the regional NGO coordination on Rural and Agricultural development)

the tea plantation … and leaving a soil cover implemented once annual intercrops end –more or less early, according farmers goals);

- "extensification", best cover based management (including practicability consideration based on low-medium labor input).

This network allows to assess performances and practicability of the designed technologies; farmers' feed back and technical and economic performances range (complete monitoring of cost, labor time, annual crops income, tea development …); it should be design in connection with both TSP technical teams and NGOs coordination to progressively implement and monitor a tea plots and farms network (including the different types of tea plantations -age, quality, market integration, TSP support …). Such a network could receive complementary funds from provincial level.

2. Uplands annual crops based experimentations

2.1 Collections

The collections must be perennial and progressively completed through a permanent process of introduction and selection (within progressively designed cropping systems – see below the "cropping systems' matrix" experimentation).

They are mainly implemented under totally controlled conditions in Phu Tho province from 2009.

Most interesting species are also implemented in (annual crops varieties selection in the targeted cropping systems) and around (fodder-cover crops behaviour assessment and species demonstration for farmers) the "cropping systems matrix" experimentation, in Van Chân district (Yên Bai province).

2.1.1 Food crops

All this collection must first gather all material selected in SAM project (see Mr. Ha Dinh Tuân, Olivier Husson and André Chabanne).

Legumes species

Soybean: regroup selected Vietnamese germplasm for northern mountainous area

- DT 84 (short cycle),
- Brazilian var. (introduced from Cambodia - PADAC),
- Thai germplasm (Chiang Mai region)

Bean

- Introduced varieties from sub-tropical areas (South Brazil, Madagascar Highlands)
- Completed by Vietnamese var.

Peanut: regroup selected Vietnamese germplasm for northern mountainous area (see with Mr. Nguyen Quang Tin the team working on peanut cultivation improvement in Mu Cang Chai district)

Vigna unguiculata

- Var. selected in Cambodia from various origin (Vigna 1, Black Eye, CNC 870-7E, David, SPLM 1, SPLM 2 …)
- Completed by Vietnamese var.

Vigna umbellata

- Introduce collection from Lao PDR (one var. -brown grains- available in Cambodia)

Pigeon Pea (Cajanus cajan)

- Introduced collection from PADAC-Cambodia (var. Fava Larga, Bonamigo + 1 var. from Thailand with big grains)
- See possible complement to be introduced from Lao PDR

Dolichos lablab

- one var. with brown grain available in Cambodia (animal feed)
- introduce one var. with white seeds from Madagascar (or Lao PDR if available)

Voandzeia subterranea
- to be introduced from Madagascar

See also introduction in the collection of the sp. named "Kudzu", considered as the hardiest pulse species by farmers.

Grass weeds species

Upland Rice
- CIRAD 141, B22, … see Cho' Don collection + Vietnamese selection
- Introduction of the rainfed rice collection recommended by Lucien Seguy : IRAT 190 to 196 + IRAT 238 to 258 + CIRAD 391 to 408

Corn varieties
- A4, Irat 200 (short cycle), Irat 340 (available in Cambodia)

N.B. Corn var. are mainly used in cropping systems with corn as secondary crops (late sowing in association with cover crops after a main cycle with legumes –see cropping systems proposals below); when corn grown as main crops, use best selected commercial hybrid var.).

Sorghum
- PADAC collection: Irat 203, Irat 321, Irat 377, CEP 316.10.12, CEP 322.36.11, CEP 396.10.12, CEP 418.13.21 + Pool "preto" (S. guineensis – photosensible)

Millet (*Pennisteum typhoides*)
- Introduce pool var. from Cambodia (Brazilian selection)

Finger Millet (*Eleusine coracana*)
- PADAC collection: PG 94, PG 2175, PG 5323, PG 6240

Black Oat (Avena strigosa)
- Introduce collection from Lao PDR and/or Madagascar (to be assessed in early first cycle or late second cycle)

Other species

- Cassava - gather Vietnamese var. + introduction of Lao collection (origin Lao & Thai)
- Sesame (*Sesamum indicum*) – local var. + Cambodia
- Buckwheat (*Fagopyrum esculentum*) – from Lao PDR
- Radish (*Raphanus sp.*) – local species with short cycle

2.1.2 Fodder and cover crops

Legumes species

- Arachis pintoi var. Amarillo
- Arachis repens (reported with higher shade tolerance)
- Chamaecrista rotundifolia
- Centrosema pascuorum var. Cavalcade
- Crotalaria retusa, C. spectabilis, C. Juncea
- Desmodium intortum
- Desmodium ovalifolium (reported as shade tolerant)
- Lotus uloginosus
- Macroptilium atropurpureum (Siratro)
- Mucuna pruriens, M. aterrinum
- Pueraria phaseoloides

- Stylosanthes guianensis var. Ciat 184
- Trifolium sp. (see sp. and var selected for Madagascar Highlands)
- Vicia sativa, V. Villosa
- Legumes "bushy" species (fencing, forage bank …)
  different genus: *Calliandra calothyrsus, Flemingia congesta, Gliricidia sepium, Leucaena leucocephala, Sesbania sp., Tephrosia sp.*.

Grass weeds species

- Brachiaria brizantha var. Marandu, MG4 and MG5 (Matsuda seeds company)
- Brachiaria decumbens (degraded area rehabilitation)
- Brachiaria ruziziensis
- Brachiaria hybrid (B. briz. x B. ruz.) var. Mulato
- Brachiaria humidicola (degraded area rehabilitation)
- Cynodon dactylon
- Panicum maximum var. Tanzania, Mombaça, …
- Paspalum notatum var. pensacola
- Pennisetum clandestinum (alive cover based systems)
- Pennisetum purpureum (forage bank)
- Bana Grass (sterile hybrid – introduce cuttings- P. purpureum x P. typhoides)

See possible complements with available local collections.

2.1.3 Other collections

Besides these food annual and fodder-cover crops collections, NOMASFI should enlarge its perennial crops collections:

- Fruits (already existing)
- Rubber (development of a budwood garden collection and training of technicians on budwood garden and nursery management)
- Bamboo (collect the high bamboo sp. diversity present in North Vietnam – especially on Phu Tho province)
- High quality forest tree species (in coordination with Forestry Research Institute – see possibility to develop arboreta in between Rubber tree where Rubber plays the role of a 30 years relay crop)

2.2 "Cropping systems matrix" experimentation

3 x 15 elementary plots of about 200 m² (e.g. 10 m large x 20 m long following contour line design)
+ around 3 x 20 elementary plots of 50 m² (5 x 10 m) for diversification systems, thematic test (*e.g.* varieties assessment, soil smouldering -"Ecobuage"- test …) and small scale cover crops collections.
Total area: around 2,0 ha on a long and steep slope, representative of the upland "landscape unit"
Implementation: 2009 with plots and terraces design, Rubber planting (if top quality planting material available - contact RRIV), fencing and cover crops sowing during 2nd cycle (August) in order to start on implemented cover in 2010.
Location: Village in Nam Bung commune (Van Chân district – Yên Bai Province)

The experimental plot is chosen and rent in a village territory and is representative of the upland fields (plot history is known with the description of the practices, the technical and economic performances on the last 3 years -at least-).

The preliminary Farming Systems Studies planned will allow to precise the place of the upland annual cultivation (apparently attractive market opportunities for Maize, Cassava, Peanut and Soybean) in the productions systems and retrace its recent evolution in the past years; if important changes have been lately induced, reason and "incentive" for these "new" dynamics are understood

and potential impacts on mobilized natural resources are characterized (externalities and sustainability of the practiced systems).

Elementary plots measure around 200 m² (minimum size for first labour time and practicability assessment), each system is replicated on 3 levels of fertilizers (even the "Farmers reference" modelling); "systems stripes" (designed as contour lines) are separated by a 1 m width alleys (cover of Arachis and/or P. notatum);

N.B. every 4-5 stripes possibility to implement a double row of Rubber trees on a coupled terraces: distance between coupled lines around 3-4 m with trees every 2,25 m on the lines; planting is done with 1 whorl polybag in July-August; prepare planting material with 2 whorls for dead trees replacement 10 months after planting (see Rubber specialist for planting material – possibility to implement here a collection of various clones) ; the "matrix" then becomes an example of long term association between perennial (Rubber tree at a low density of about 200 trees/ha) and annual crops systems.

Secondary systems (regrouped in "diversification and thematic studies stripes") are tested on 50 m² elementary plots (also 3 fertilizers levels).

In a first approach (to be specified according to climatic data), short term bio-pumps (see below) are sown during 1st half of March; main 1st cycle during 1st half of April (earlier if regular rains).

2.2.1 Technical description of the Cropping systems

Farmers' management Reference

Main farmers' practices (diagnosis survey) on upland management is "reproduced" in the matrix; according to interviews with researchers, "traditional" management relies on a 5-6 years crops succession (1 or 2 years of Rice, 2 years of Maize and 1 or 2 years of Cassava) followed by a fallow period (evolution of the fallow duration in the recent years should be clarified during diagnosis phase); soil preparation is done by a slight hoe tillage combined with the burn of the crops residues. In the experimentation, the "farmers management reference" is based on the farmers cropping plan, prior to the plot renting.

Systems 1 to 4 are DMC based "monocropping" on dead cover of Stylosanthes guianensis or Brachiaria ruziziensis cover.

1- Maize + Stylosanthes g. // Stylo. / Maize + Stylo.

Monocropping of Maize on a Stylosanthes guianensis cover.
Maize (hybrid var.) is sown around 5-10 July with 0,80 cm interrows; Stylo. is sown in the middle of the Maize interrow at 20 DAS (Days After Sowing). The following year, Stylo. is controlled by herbicide application (3 l glyphosate + 1 l 2,4 D) around 40 days prior to sowing or manually (around 15 days prior to sowing).

2- Rice + Stylosanthes g. // Stylo. / Rice + Stylo.

Monocropping of upland Rice on a Stylosanthes guianensis cover.
Rice (medium cycle var. # 115-120 days) is sown around 1-5 July with 0,40 cm interrows; Stylo. is sown in the middle of the Rice interrow at 20 DAS (Days After Sowing).

3- Soybean + Brachiaria r. // Brach. / Soybean + Brach.

Soybean (medium cycle var. # 115-120 days) is sown around 1-5 July with 0,40 cm interrows; Brachiaria. is sown by broadcasting seeds (10 kg/ha) at the first yellow leaves appearance, around 30 days prior to harvest. The following year, in case of insufficient Brachiaria implementation, a short term bio pump (Millet, Eleusine or Sorghum, line sowing at 0,4 m interline) is oversown on the Brachiaria in March

4- Peanut + Brachiaria r. // Brach. / Peanut + Brach.

Monocropping of Peanut on a Brachiaria ruziziensis cover.
Peanut (medium cycle var. # 115-120 days) is sown around 1-5 July with 0,40 cm interrows; Brachiaria. is sown by broadcasting seeds (10 kg/ha) at the first yellow leaves appearance, around 30 days prior to harvest.

Note: due to possible difficulties for the Stylo. management (if strong growth, or in contrary, insufficient growth with cool temperatures….) on steep slopes, diversification stripes prospect feasibility for DMC of:

- Maize or Rice on live or dead cover of Chamaecrista rotundifolia, Trifolium sp.,
- Maize, Rice or Cassava on live cover of Arachis pintoi (post application at 20-for Maize-30 days -for Rice and Cassava- of 3 g./ha of metsulfuron methyl to control regrowth of cover; use a mask for Cassava)
- Soybean and Peanut on live cover of Pennisetum clandestinum (post application at 20-25 days of 40g/ha of fluazifop p butyl).

Systems 5 to 8 are DMC based bi-annual crops rotation between Maize and Rice or Cassava with Stylosanthes cover and between Maize and Soybean or Peanut with Brachiaria cover and Stylosanthes covers.

5- Maize + Stylosanthes g. // Cassava + Stylo.

Bi-annual rotation between Maize and Cassava on a Stylosanthes guianensis cover.
Maize (hybrid var.) is sown around 5-10 July with 0,80 cm interrows; Stylo. is sown in the middle of the Maize interrow at 20 DAS (Days After Sowing). The following year, Stylo. is controlled by herbicide application (3 l glyphosate + 1 l 2,4 D) around 30 days prior to Cassava planting or manually (around 15 days prior to sowing); Stylo. is resown in Cassava interrow at 0 DAS

6- Maize + Stylosanthes g. // Stylo. / Rice + Stylo.

Bi-annual rotation between Maize and Rice on a Stylosanthes guianensis cover.
Maize (hybrid var.) is sown around 5-10 July with 0,80 cm interrows (id. for Stylo implementation); the following year, Stylo. is controlled by herbicide application (3 l glyphosate + 1 l 2,4 D) around 40 days prior to Rice sowing or manually (around 15 days prior to sowing); Stylo. is resown in Rice interrow at 30 DAS

7- Maize + Brachiaria r. // Brach. / Soybean + Stylo.

Bi-annual rotation between Maize and Soybean on a Stylosanthes guianensis and Brachiaria ruziziensis covers.
Maize (hybrid var.) is sown around 5-10 July with 0,80 cm interrows; Brach. is sown in the middle of the Maize interrow at 25 DAS; the following year, Brach. is controlled by herbicide application (2,5 l glyphosate + 1 l 2,4 D) around 30 days prior to Soybean sowing; Stylo. is sown in Soybean interrow (broadcast 3 kg/ha) at first yellow leaves appearance at 30 DAS

8- Maize + Brachiaria r. // Brach. / Peanut + Stylo.

Bi-annual rotation between Maize and Peanut on a Stylosanthes guianensis and Brachiaria ruziziensis covers.
Maize (hybrid var.) is sown around 5-10 July with 0,80 cm interrows; Brach. is sown in the middle of the Maize interrow at 25 DAS; the following year, Brach. is controlled by herbicide application (2,5 l glyphosate + 1 l 2,4 D) around 30 days prior to Peanut sowing; Stylo. is sown in Peanut interrow (broadcast 3 kg/ha) at 30 DAS prior to harvest

Diversification stripes prospect feasibility for DMC rotation on mix cover:

- Maize in association with Eleusine (sown on Maize line) and Trifolium sp. + Centrosema pascuorum (alternate line sown at 20 DAS in the middle of the Maize interrow) in rotation with Rice; Trifolium sp. + Centrosema pascuorum are resown (if necessary) in the Rice interrow at 30 DAS
- Maize in association with Eleusine, Trifolium sp. and Centrosema p. in rotation with Cassava; Trifolium sp. + Centrosema pascuorum are resown in the Cassava interrow at 0 DAS
- Maize in association with Stylosanthes g. + Brachiaria r. (alternate line sown at 20 DAS in the middle of the Maize interrow) in rotation with Soybean; Stylosanthes g. + Brachiaria r. are resown (broadcast sowing 2 + 8 kg/ha) at first yellow leaves appearance
- Maize in association with Stylosanthes g. + Brachiaria r. in rotation with Cassava; Stylosanthes g. + Brachiaria r. are resown (alternate line in the middle of the 0,8 m Cassava interrow) at 0 DAS

Systems 9 to 12 are DMC based annual crops succession, using Maize, Sorghum or Millet in association with a Stylo. or Brach. cover, as secondary crops cycle.

In a first approach, we can fix as sowing dead lines 1st/08, 15th/08 and 1st/09 for Maize (variety), Sorghum (non photosensitive var.) and Millet, respectively.

9- Maize / Sorghum + Stylosanthes g. // Maize / Sorghum + Stylo.

Maize and Sorghum (or Millet) annual crops succession; Stylosanthes g. is associated with the secondary cycle (Stylo. sown in the middle of the 0,8 m width interrow at 0 DAS)

10- Maize / Sorghum + Stylosanthes g. // Rice / Sorghum + Stylo.

Maize and Sorghum + Stylo. (or Millet) annual crops succession in rotation with Rice and Sorghum + Stylo. succession.

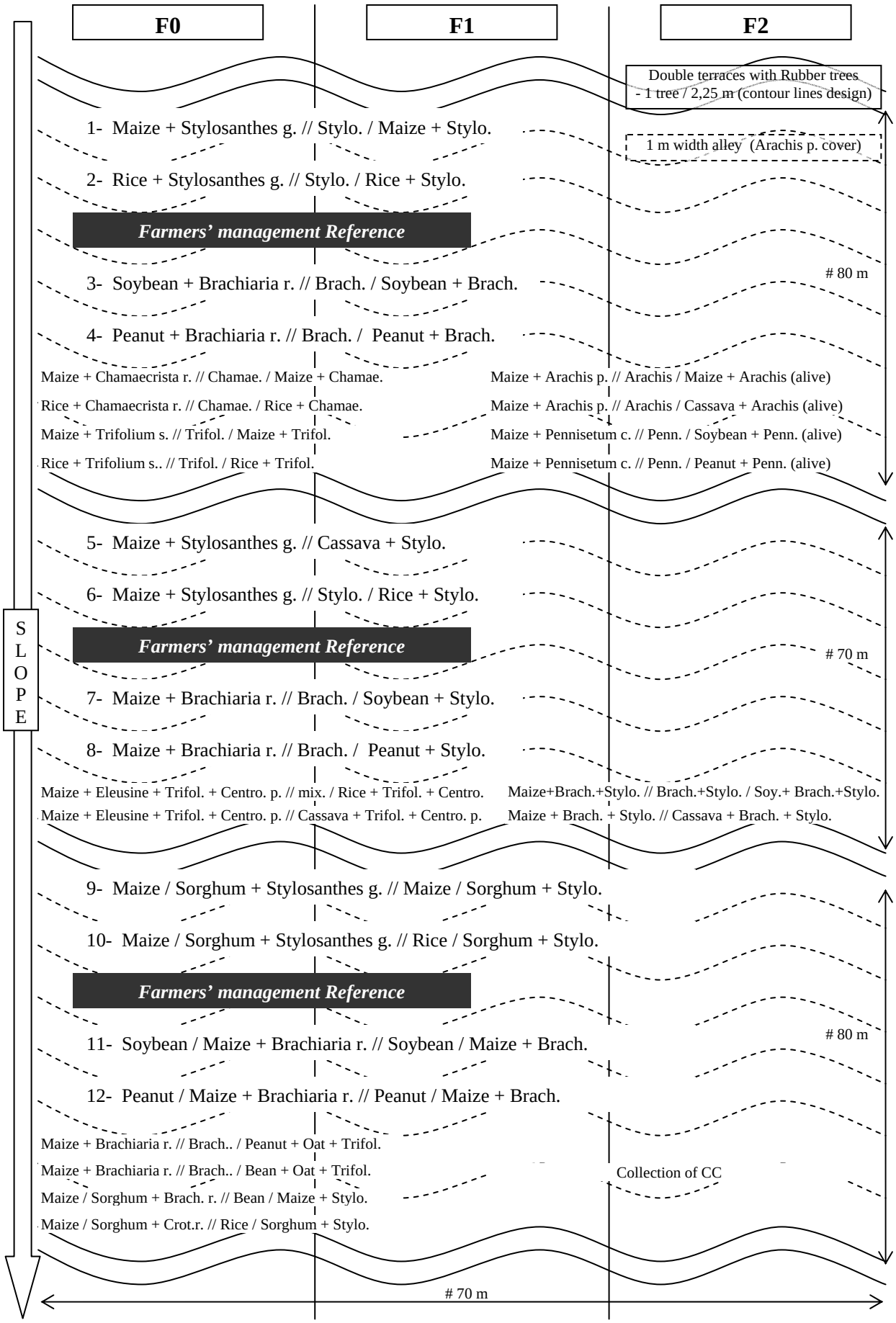
11- Soybean / Maize + Brachiaria r. // Soybean / Maize + Brach.

Soybean (short cycle) and Maize + Stylo. (or Sorghum if medium cycle Soybean) annual crops succession.

12- Peanut / Maize + Brachiaria r. // Peanut / Maize + Brach.

Peanut and Maize + Stylo. (or Sorghum) annual crops succession.

Diversification stripes prospect feasibility for various others DMC “rotation of successions” on different cover type (attempt of a 3rd cycle with winter Oat, test of Crotalaria retusa cover prior to rice cultivation).


F0
F1
F2
Double terraces with Rubber trees
- 1 tree / 2,25 m (contour lines design)
1 m width alley (Arachis p. cover)
1- Maize + Stylosanthes g. // Stylo. / Maize + Stylo.
2- Rice + Stylosanthes g. // Stylo. / Rice + Stylo.
Farmers' management Reference
80 m
3- Soybean + Brachiaria r. // Brach. / Soybean + Brach.
4- Peanut + Brachiaria r. // Brach. / Peanut + Brach.
Maize + Chamaecrista r. // Chamae. / Maize + Chamae.
Rice + Chamaecrista r. // Chamae. / Rice + Chamae.
Maize + Trifolium s. // Trifol. / Maize + Trifol.
Rice + Trifolium s.. // Trifol. / Rice + Trifol.
Maize + Arachis p. // Arachis / Maize + Arachis (alive)
Maize + Arachis p. // Arachis / Cassava + Arachis (alive)
Maize + Pennisetum c. // Penn. / Soybean + Penn. (alive)
Maize + Pennisetum c. // Penn. / Peanut + Penn. (alive)
5- Maize + Stylosanthes g. // Cassava + Stylo.
6- Maize + Stylosanthes g. // Stylo. / Rice + Stylo.
SLOPE
Farmers' management Reference
70 m
7- Maize + Brachiaria r. // Brach. / Soybean + Stylo.
8- Maize + Brachiaria r. // Brach. / Peanut + Stylo.
Maize + Eleusine + Trifol. + Centro. p. // mix. / Rice + Trifol. + Centro.
Maize + Eleusine + Trifol. + Centro. p. // Cassava + Trifol. + Centro. p.
Maize+Brach.+Stylo. // Brach.+Stylo. / Soy.+ Brach.+Stylo.
Maize + Brach. + Stylo. // Cassava + Brach. + Stylo.
9- Maize / Sorghum + Stylosanthes g. // Maize / Sorghum + Stylo.
10- Maize / Sorghum + Stylosanthes g. // Rice / Sorghum + Stylo.
Farmers' management Reference
80 m
11- Soybean / Maize + Brachiaria r. // Soybean / Maize + Brach.
12- Peanut / Maize + Brachiaria r. // Peanut / Maize + Brach.
Maize + Brachiaria r. // Brach.. / Peanut + Oat + Trifol.
Maize + Brachiaria r. // Brach.. / Bean + Oat + Trifol.
Maize / Sorghum + Brach. r. // Bean / Maize + Stylo.
Maize / Sorghum + Crot.r. // Rice / Sorghum + Stylo.
Collection of CC
70 m

2.2.2 Technical precisions on Fertilizers level

Fertilizers levels are summarized in the table below.

a/ fumure de fond = 0	a/ fumure de fond = 0 - 35 - 0 - 200 kg/ha de thermophosphate		a/ fumure de fond = 0 - 85 - 30 - 500 kg/ha de thermophospł - 50 kg/ha de KCl - 20 ZNSO4 + 10 MnSO4 + 10 NeoB + 5 CuSO4	
b/ apport en couverture (top dressing)	b/ apport en couverture (top dressing)		b/ apport en couverture (top dressing)	
50 kg/ha Urée à 0 JAS sur les cultures principales des itinéraires de semis direct (SCV)	Riz 50 kg/ha KCl à 0 JAS 50 kg/ha Urée à 0 JAS 50 kg/ha Urée à 25 JAS	45-35-30	Riz 50 kg/ha KCl à 0 JAS 50 kg/ha Urée à 0 JAS 50 kg/ha Urée à 25 JAS 50 kg/ha Urée à 40 JAS	69-85-60
	Maïs 50 kg/ha KCl à 0 JAS 50 kg/ha Urée à 0 JAS 100 kg/ha Urée à 25 JAS	69-35-30	Maïs 50 kg/ha KCl à 0 JAS 50 kg/ha Urée à 0 JAS 100 kg/ha Urée à 25 JAS 100 kg/ha Urée à 40 JAS	115-85-60
	Soja 50 kg/ha KCl à 0 JAS 50 kg/ha Urée à 0 JAS 50 kg/ha KCl à 30 JAS	23-35-60	Soja 50 kg/ha KCl à 0 JAS 50 kg/ha Urée à 0 JAS 50 kg/ha KCl à 30 JAS **Mo**, en foliaire à 25 & 45 JAS	23-85-90
	Manioc 50 kg/ha KCl à 30 JAS 50 kg/ha Urée à 30 JAS 100 kg/ha Urée à 60 JAS 50 kg/ha KCl à 60 JAS	69-35-60	Manioc 50 kg/ha KCl à 30 JAS 50 kg/ha Urée à 30 JAS 100 kg/ha Urée à 60 JAS 50 kg/ha KCl à 60 JAS 50 kg/ha Urée à 90 JAS	92-85-90

In F2 (“potential”), the “main” Micro-nutrients (Zn, Mn, B and Cu) are applied for 3 years; see possibility to replace for the main crops the first 50 kg/ha Urea application by a 100 kg/ha Ammonium sulphate (S supply)

The cropping systems design will evolve with a “practical” knowledge of the soil and climate conditions, of the behaviour of the cover crops (especially growth and biomass production during the dry and cool-cold season, feasibility -herbicide- or acceptability -manual- of the control on a steep slope …) …

2.3 Scaling up and demonstration plots

From the 2011 cropping season, ADAM will start to implement large scale (same size than farmers’ plots) demonstration plots (also directly managed by project on rented plots) for the “best” cropping systems (technical and economic performance) in order to improve practicability (adapted tools selection for sowing, herbicide treatment -sweeping brush, ULV …) and precise performances under an enlarged range of real conditions (re-crossing the local physical conditions -soil’s types, slopes, altitude …).

First farmers' plots network is implemented in parallel (experimentation contracts) with a close support from the projects technicians. First farmers' plots can be implemented through an approach focusing on:

- fallow period reduction by fodder-cover crop implementation, secondary combined with a conversion to DMC management.
- land productivity intensification (second crop where only one crop cycle is done);

Conclusion

Main targets of the ADAM's R&D program

In term of technologies design

- Define practical DMC based management of Tea plantation, at all stages
    - planting
    - immature period
    - adult plantation …

… able to fit with various farmers' production orientations (intensive *vs* extensive approaches, e.g. intercropping or not during immature period, plucking intensity …) and adapted to various physical conditions (range of altitude 200 – 800 m)

- Define also, mainly through on-farm network (cross high diversification of physical and socio-economic conditions, of plantations states), (1) simple technologies for soil fertility (and tea production potential) restoration of existing plantations and (2) a grid for decision making between rehabilitation or replanting; such a network can provide an important support and allow the implementation of practical links between ADAM-NOMASFI and the TSP on Phu Tho province.

- Generate a range of sustainable and flexible technologies able to address the big variability –and variation- of farms conditions (huge physical, socio economic and cultural diversity, increasing demographic pressure, rapid raise of new market's opportunities …) instead of to aim the design of "normative cropping systems" for predetermined productions goals
    - DMC systems for annual crops (with possible associations with livestock through fodder-cover crops, secondary grains productions)
    - DMC systems designed for tea could be later extended to some other perennial monocropping systems
    - Work also on agroforestry approaches with various goals:
        - Increased and diversified incomes with perennial-perennial association (e.g. association of high value timber trees or fruit tree sp. as shading species in tea plantation)
        - Association of DMC annual crops (allowing shift to permanent cropping) with perennial species (other trees arrangement with enlarged interrow space, lower density than in monocropping systems).

N.B. this later approach may have several interests for farmers:

- cheaper way to introduce perennial crops in production systems (reduced number of plants, no immature period, …)
- "lighter" integration in a sector (less constrains in the relation between farmers and agro-industries)
- access to longer term land use right (50 years for perennial vs 10 to 20 for annual crops)
- it can be also, for farmers, an efficient incentive to change their soil's management practices (easier abandon of crops residues burning if presence of fragile young trees in the plots)

… some of the reason why it is likely more efficient to introduce trees in DMC annual crops systems (which found the sustainability of the soil resource management) than to try to promote a DMC management of intercrops during immature period (weaker interest for annual crops intensification of farmers who just made an important and costly choice with the development of their plantation; reduced interest also due to the ending of annual crops intercropping with shading progress, generally after 2-3 years, just when DMC systems start to have significantly improve soil condition and crops yields.

In term of scientific studies

According to funds and human resource availability

- soil's parameter and profile evolution under contrasted soil management techniques
    - physical parameters
    - chemical parameters
    - biological parameters

N.B. for soil evolution under tea, this study should be coupled with a better assessment of the erosion and soil's degradation under a representative range of tea plantations

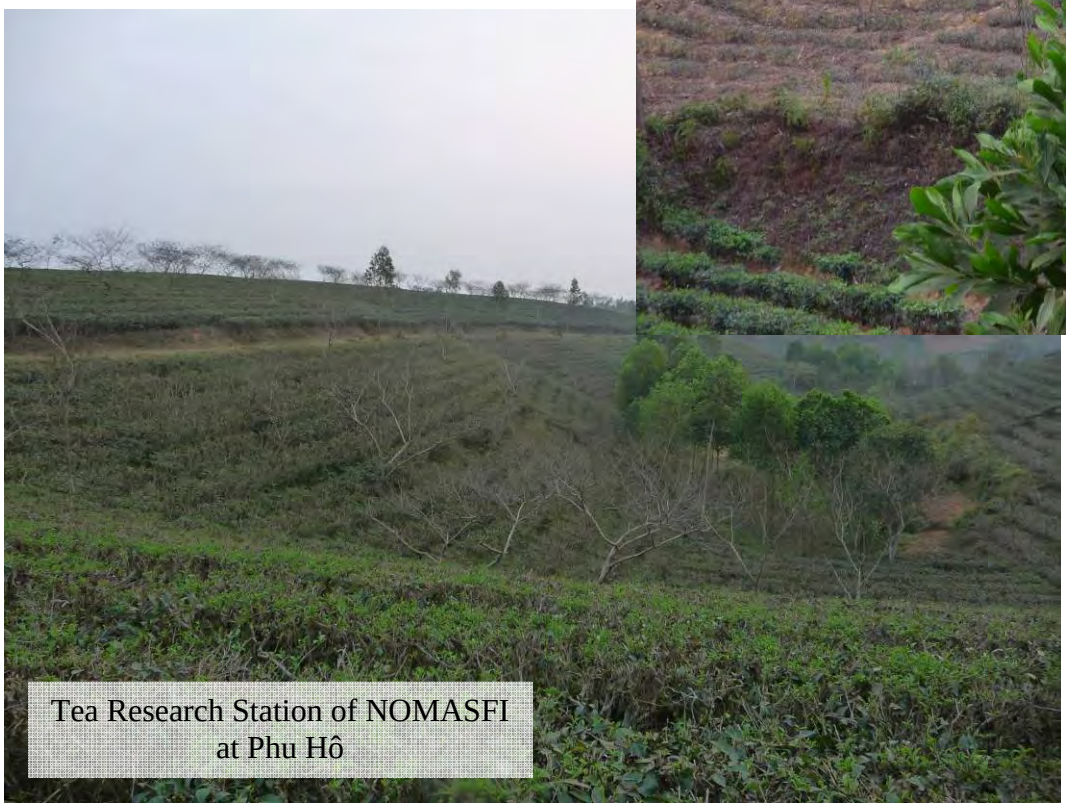
- Associated entomofauna evolution according to the type of management (biodiversity and genus identification, "functionalities", balance between pest and predators …)

Appendix I

Photos

Erosion under Tea
plantation on steep slopes

Erosion and soil degradation under Tea plantation



Tea Research Station of NOMASFI
at Phu Hô

Arachis pintoi cover in Tea plantation – NOMASFI research station

Traditionnal Shan Tea – Suoi Giang Commune – Vien Chân District

Recent Shan Tea plantation – R&D work carried out by TRI at Vien Chân Tea Company

Landscape views on the “transect” Viên Chân Tea company (Nam Bung commune) – Tu Lê

"Transect" Viên Chân Tea company (Nam Bung commune) – Tu Lê
Clear plots design on steep slopes up to the top (no more residual forest here)

RRIV small scale clonal trial (planting 2008)
Không Lao commune, Phong Thô district – Lai Châu Province


VIỆN KHCN NÔNG LÂM NGHIỆP MIỀN NÚI PHÍA BẮC
SỞ KHOA HỌC CÔNG NGHỆ TỈNH LAI CHÂU
MÔ HÌNH TRỒNG CÂY CAO SU
ĐỊA ĐIỂM : XÃ BÌNH LƯ - HUYỆN TAM ĐƯỜNG
GIỐNG : GT1; RRIV4
NGUỒNG GỐC : VIỆN NGHIÊN CỨU CAO SU VIỆT NAM
ĐỀ TÀI: TRỒNG KHẢO NGHIỆM CAO SU
Diện tích: 5ha
Loại giống: GT1, RRIV4
Địa điểm: Xã Bình Lư huyện Tam Đường

Simple experimental design for erosion and run-off assessment

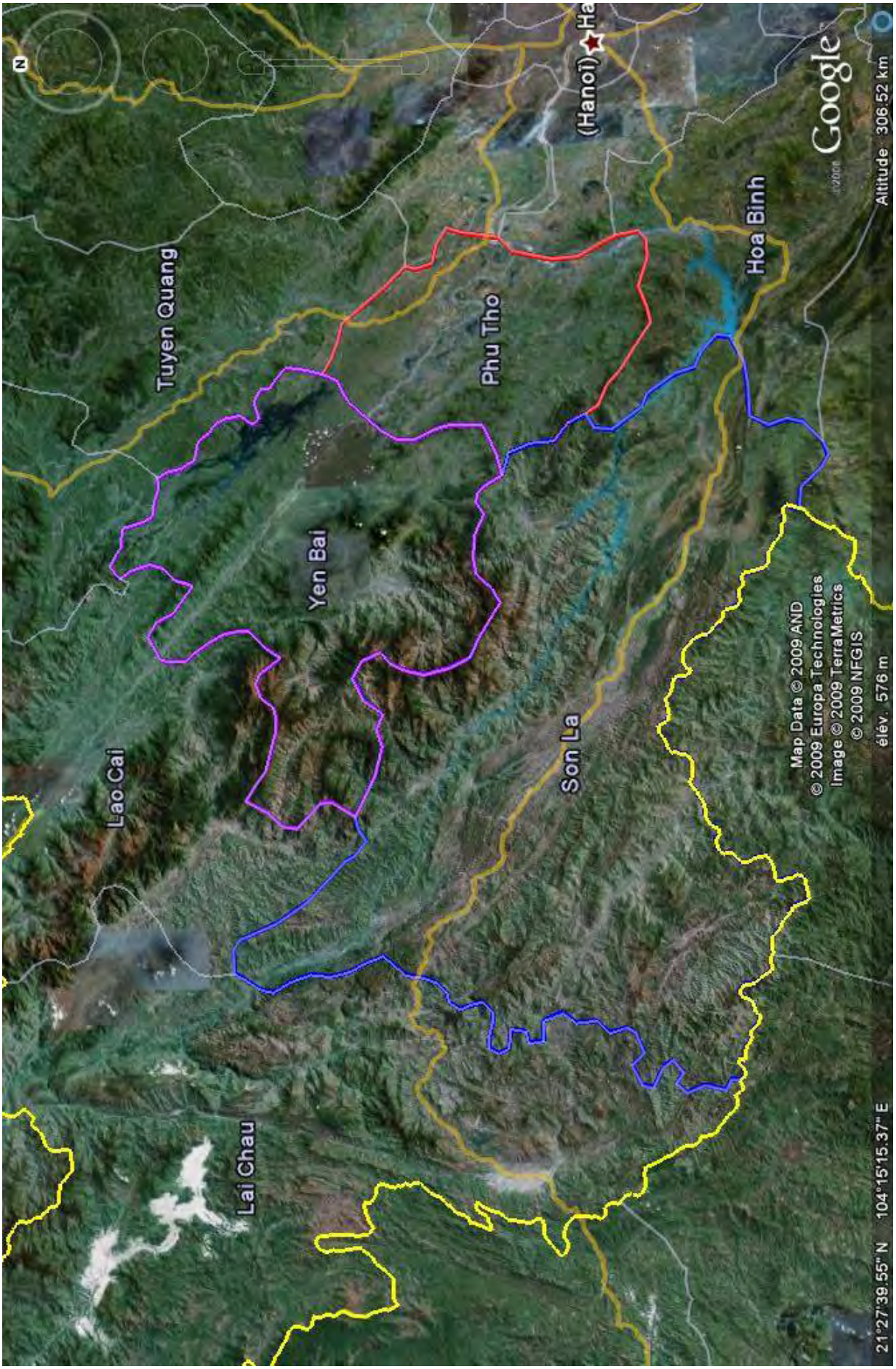
Appendix II

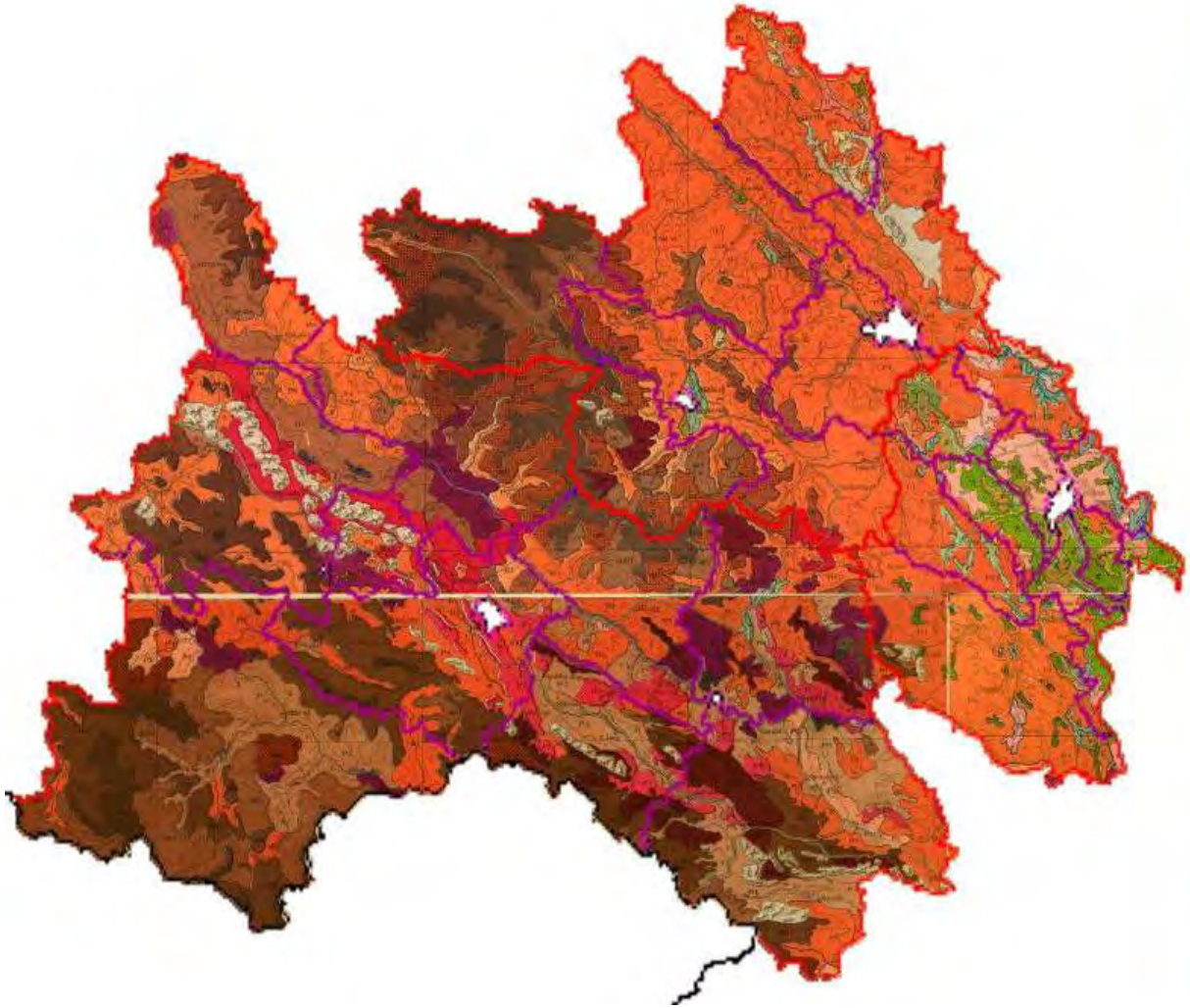
Maps

TT	ĐƠN VỊ HÀNH CHÍNH	DIỆN TÍCH (Km²)	DÂN SỐ (Người)	MẬT ĐỘ (Người / km²)
1	TP. Việt Trì	71,3	131 400	1 844
2	TX. Phú Thọ	32,0	39 200	1 226
3	H. Đoan Hùng	302,4	101 500	336
4	H. Hạ Hòa	339,9	106 400	313
5	H. Lâm Thao	130,8	122 600	938
6	H. Phù Ninh	138,4	114 700	625
7	H. Sông Thao	234,2	124 600	532
8	H. Tam Nông	155,5	79 300	510
9	H. Thanh Ba	198,6	112 600	567
10	H. Thanh Sơn	1 309,2	180 900	138
11	H. Thanh Thủy	123,8	74 400	601
12	H. Yên Lập	437,5	76 300	174
	Toàn tỉnh	**3 518,6**	**1 263 900**	**359**

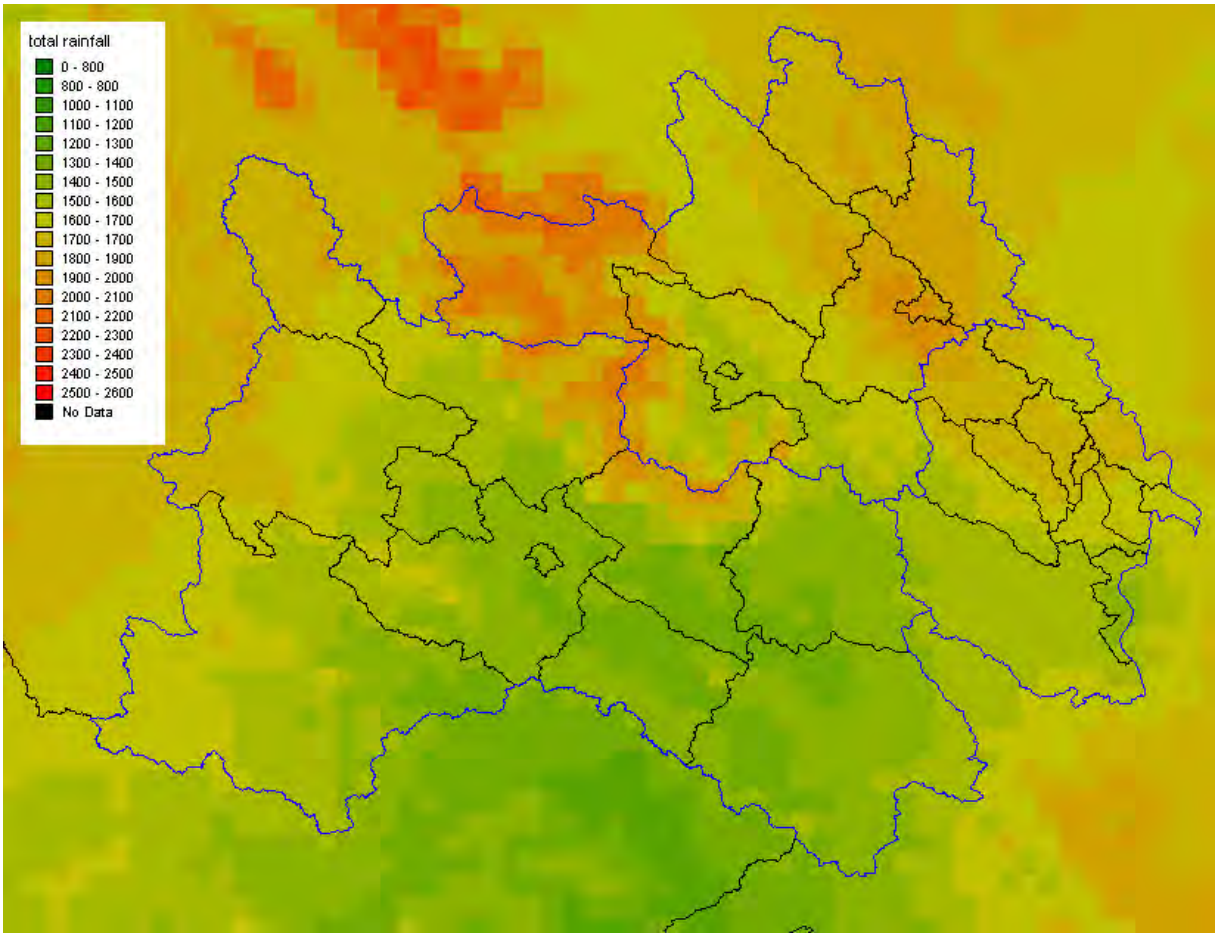
TT	ĐƠN VỊ HÀNH CHÍNH	DIỆN TÍCH (Km²)	DÂN SỐ (Người)	MẬT ĐỘ (Người / km²)
1	TP.Yên Bái	58,0	73 600	1269
2	T.X.Nghĩa Lộ	10,9	18 400	1 682
3	H.Lục Yên	807,0	96 200	119
4	H.Mù Cang Chải	1 199,3	38 200	32
5	H.Trạm Tấu	742,0	19 300	26
6	H.Trấn Yên	690,7	93 500	135
7	H.Văn Chấn	1 223,9	139 900	114
8	H.Văn Yên	1 338,8	106 200	76
9	H.Yên Bình	762,2	96 700	127
	Toàn tỉnh	**6 882,9**	**682 000**	**99**

STT	ĐƠN VỊ HÀNH CHÍNH	DIỆN TÍCH (Km²)	DÂN SỐ (Người)	MẬT ĐỘ (Người/km²)
1	TX. Sơn La	330,1	66 500	201
2	H. Bắc Yên	1 090,8	44 200	41
3	H. Mai Sơn	1 410,3	112 800	80
4	H. Mộc Châu	2 025,1	130 500	64
5	H. Mường La	1 407,9	67 800	48
6	H. Phù Yên	1 227,3	96 500	79
7	H. Quỳnh Nhai	792,8	31 400	40
8	H. Sông Mã	3 135,6	131 400	42
9	H. Thuận Châu	1 791,5	148 200	83
10	H. Yên Châu	843,7	57 100	68
	Toàn tỉnh	**14 055,0**	**886 400**	**63**


Tuyen Quang
Lao Cai
Yen Bai
Phu Tho
(Hanoi)
Hoa Binh
Son La
Lai Chau
Map Data © 2009 AND
© 2009 Europa Technologies
Image © 2009 TerraMetrics
© 2009 NFGIS
élév. 576 m
Google
Altitude 306.52 km
21°27'39.55" N 104°15'15.37" E




CHỦ DẪN
KÝ HIỆU
ĐỊA HÌNH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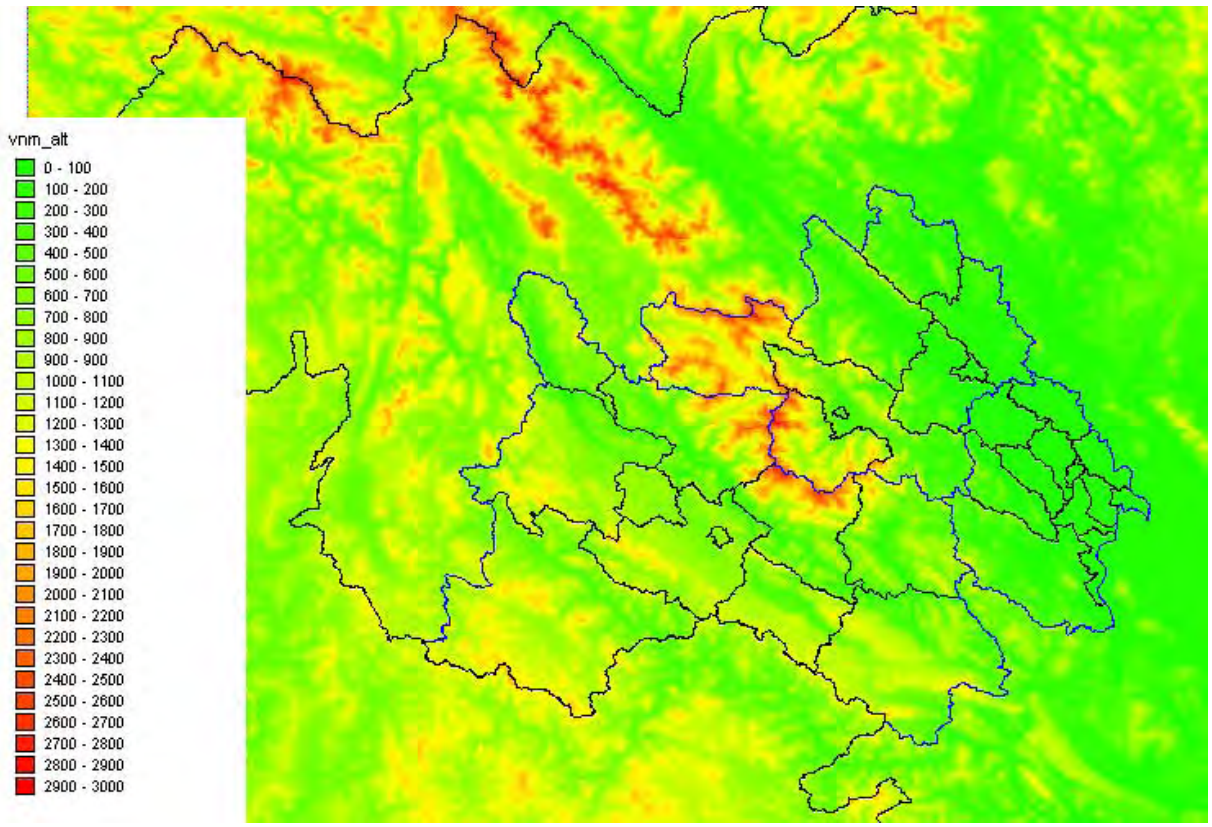
800 - 800
1000 - 1100
1100 - 1200
1200 - 1300
1300 - 1400
1400 - 1500
1500 - 1600
1600 - 1700
1700 - 1700
1800 - 1900
1900 - 2000
2000 - 2100
2100 - 2200
2200 - 2300
2300 - 2400
2400 - 2500
2500 - 2600
No Data


vnm_alt
0 - 100
100 - 200
200 - 300
300 - 400
400 - 500
500 - 600
600 - 700
700 - 800
800 - 900
900 - 900
1000 - 1100
1100 - 1200
1200 - 1300
1300 - 1400
1400 - 1500
1500 - 1600
1600 - 1700
1700 - 1800
1800 - 1900
1900 - 2000
2000 - 2100
2100 - 2200
2200 - 2300
2300 - 2400
2400 - 2500
2500 - 2600
2600 - 2700
2700 - 2800
2800 - 2900
2900 - 3000